UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
ROBERT M. SALTER, CHIEF
NORTHEASTERN REGION
AUSTIN L. PATRICK, REGIONAL DIRECTOR

REPORT
— ON —
SEDIMENTATION
— IN —
CARNEGIE LAKE

Princeton, New Jersey

By William R. Moore, Soil Conservationist

H. James Ferris, Soil Scientist

and

John Kozachyn, Soil Scientist

Soil Conservation Service

SCS-TP-109
Upper Darby, Pa.
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INTRODUCTION

This is a report on a detailed sedimentation survey of Carnegie Lake, located one-half mile east of Princeton, New Jersey. The survey was made in September 1950, by the Soil Conservation Service, U. S. Department of Agriculture.

The purposes of the survey were: (1) to determine the original and present capacity of Carnegie Lake and the loss of capacity by sedimentation; (2) to evaluate the prevailing rate of sediment production from the drainage area; and (3) to provide a basis for determining the effects of a watershed treatment program in prolonging the useful life of the lake.

DAM AND RESERVOIR

Carnegie Lake is a shallow channel-type lake created in 1907 on the Millstone River, one-half mile east of Princeton, New Jersey (fig. 1). It was constructed by Princeton University and is used for recreation. The lake is formed by a concrete overflow dam, 18 feet high and 650 feet long, located at Kingston, New Jersey.

Carnegie Lake is Y-shaped with the major portion extending up Stony Brook, which is a principal tributary to the Millstone River. The average width of the lake is 517 feet throughout the 3.5 mile length from the dam to the Pennsylvania Railroad trestle. The backwater of the lake extends up Stony Brook arm for approximately 2 miles above the railroad trestle. Here it is confined to its original channel, which averages about 50 feet wide.

The University boathouse is located on the left bank of the Stony Brook arm of the lake about one-half mile below the railroad trestle. The canoehouse is approximately 1 mile below the boathouse. Two vehicular bridges span the lake--the Washington Street Bridge, 500 feet below the University boathouse, and the Harrison Street Bridge approximately 3,800 feet below the boathouse. The Delaware and Raritan Canal, which runs along the right bank of the lower section of the lake, crosses the Millstone arm of the lake by means of a small aqueduct. The aqueduct, together with the shallow and weedy nature of the part of the lake in the main stem of the Millstone above it, is the reason most of the aquatic sports are carried on in the Stony Brook arm.

The total original storage capacity, based on the results of the present survey, was 1355 acre-feet. The water surface area at crest stage elevation 365 feet is 260 acres.

THE DRAINAGE AREA

PHYSIOGRAPHY AND GEOLOGY

Carnegie Lake lies on the boundary between two physiographic provinces, the Piedmont Plateau and the Atlantic Coastal Plain.

The Millstone River rises in and flows through the coastal plain area, which is characterized in this region by level to gently rolling topography. The underlying geological formations in the coastal plain area are chiefly unconsolidated and nearly horizontal beds of sand, silt, clays, and glauconite accumulated by sedimentation in water.

Stony Brook Watershed lies in the Piedmont Plateau. The topography in this area is rolling to hilly, resulting in a winding stream of high gradient that in places has a narrow, steep-sided rock-controlled channel. Narrow trap rock and sandstone ridges alternate with broader shale valleys generally extending northeast - southwest across which the Stony Brook winds in a southeasterly to southerly direction.

The underlying rock formations of the Piedmont area are soft red shales, sandy shales, red or gray massive argillite, thicker bedded harder shale, deeply weather sandstone, and moderately coarse intrusive diabase with metamorphosed shale borders. Block faulting has caused the formations to appear in repetitious succession. The diabase was injected as sills along the bedding of the other formations and in places it cut across them as dikes.

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CARNEGIE LAKE WATERSHED
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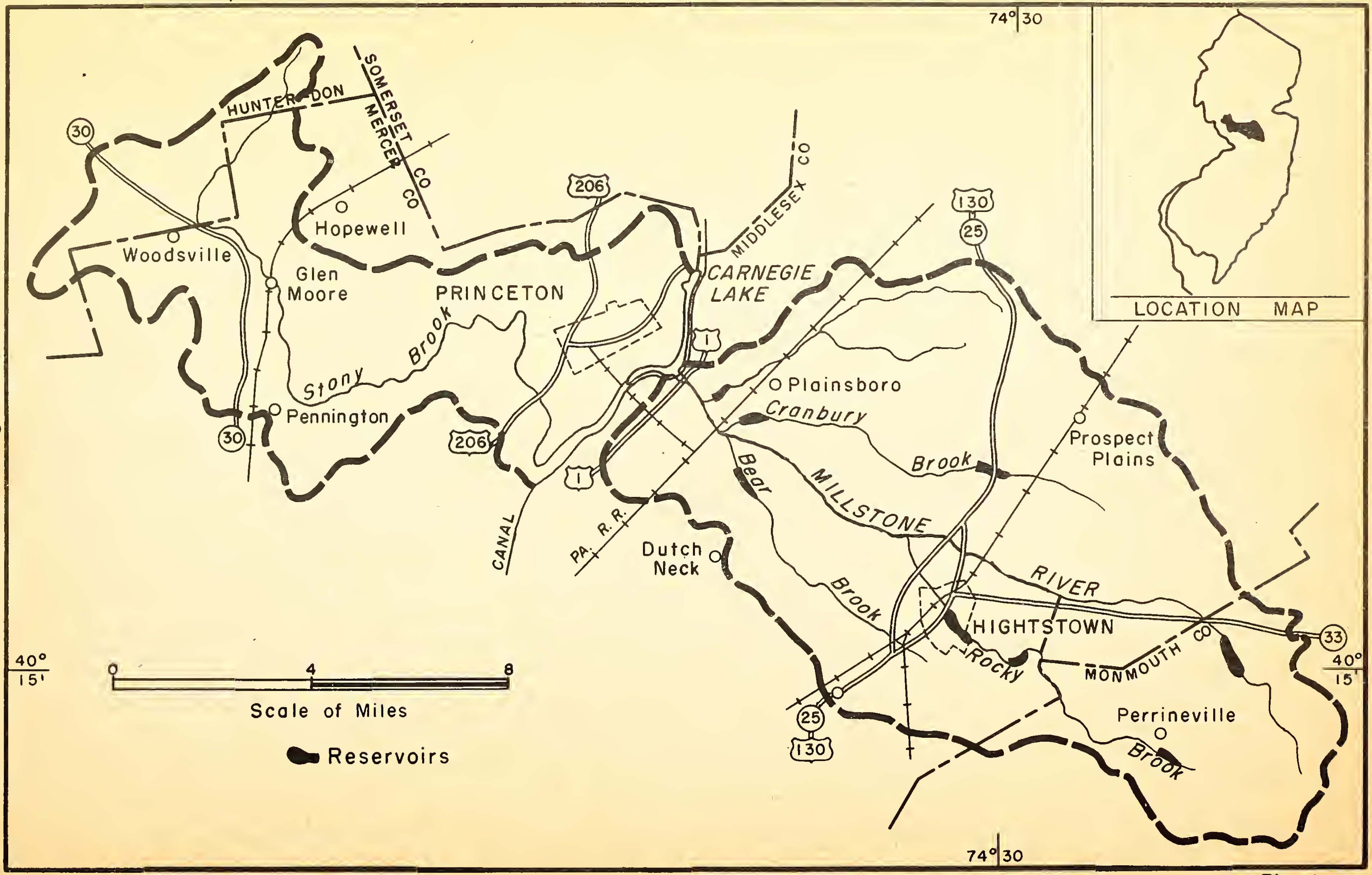

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MARCH 1952

Fig. 1

SOILS

The headwaters of the Millstone River lie in an area dominated mainly by deep, permeable, sandy loam or fine sandy loam soils derived from unconsolidated sands, silts, and clays. The largest part of the drainage area below the headwaters is composed of similarly textured soils that are underlain by more sandy materials. The sandy nature of the soils permits rapid intake of water. This factor, plus other favorable conditions for water retention, results in low surface runoff.

A majority of the soils in the Stony Brook Watershed have silt loam surfaces, with heavier silt loam or silty clay loam subsoils. A considerable portion are only 10 to 20 inches deep over bedrock. Most of the deep soils are compact in the substratum. In general, the result is a moist, cold land, crossed at varied intervals by narrow, shallow, shaly ridges. Runoff is notably high, sheet erosion is intensive, and wetness is a general problem.

LAND CAPABILITY

One of the most important factors influencing erosion and the rate of sediment production is the use of land according to its capability. In the Stony Brook Watershed 1/ about 64 percent of the land is in capability classes I, II, and III, which are considered safe for continuous cultivation (fig. 2). At the time of the survey about 86 percent of the cultivated land was within those classes. Thirteen percent of the watershed area is in land capability class IV, which is land suitable for occasional cultivation. Over 11 percent of the cultivated land was mapped in this class. Two percent of the cropland was found to be in classes VI and VII, which are not recommended for cultivation. Classes VI and VII cover a little over 20 percent of the watershed area.

The most important land use adjustment in the watershed appears to be one of reducing the percentage of cultivated crops on the land unsuitable for continuous cultivation (particularly classes IV, VI, and VII) and increasing the percentage of grass and woody vegetation on this area. In addition, the idle land, 14.4 percent of the watershed, can be put into production. Two-thirds of it is suitable for crops while one-third is best suited for pasture or woodland.

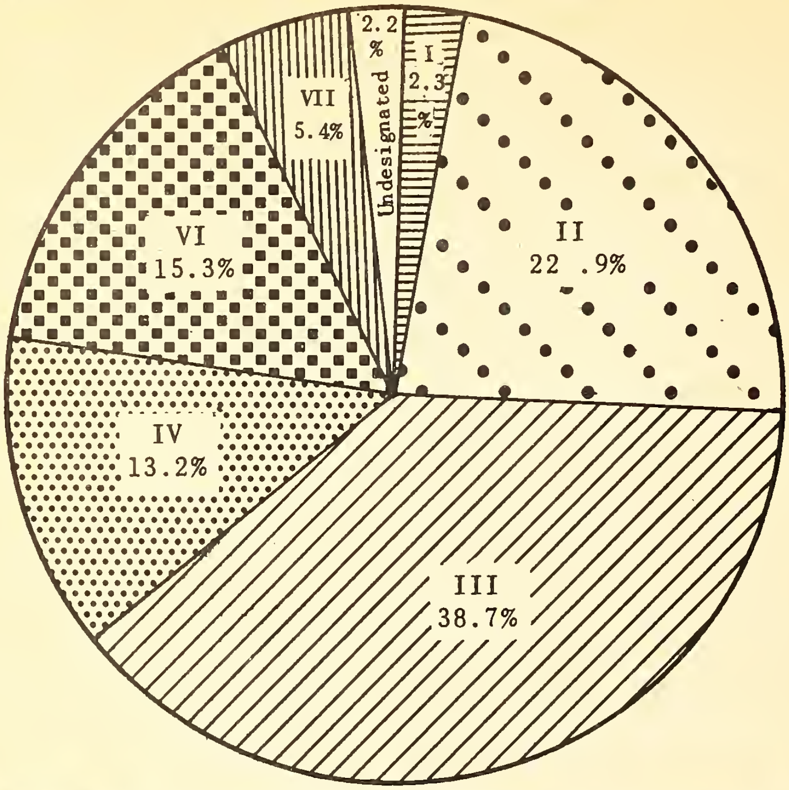
Table 1 is a general summary of present land use in each land capability class in Stony Brook Watershed.

Table 1. PRESENT LAND USE IN EACH LAND CAPABILITY CLASS STONY BROOK WATERSHED

LAND USE	CAPABILITY CLASSES							
	I %	II %	III %	IV %	VI %	VII %	Undesignated %	Percent of Watershed
Cropland	1.8	14.4	21.7	5.0	.5	.4		43.8
Grass Land	.2	1.2	3.6	2.2	2.0	.1		9.3
Woodland	.1	2.6	4.6	2.6	11.5	4.6		26.0
Idle	.1	2.8	7.3	3.0	1.0	.2		14.4
Farmsteads and Misc.	.1	1.9	1.6	.4	.2	.1	2.2	6.5
Percent of Watershed	2.3	22.9	38.8	13.2	15.2	5.4	2.2	100.0

1/ The remainder of this report deals almost entirely with the Stony Brook Watershed because of the low rate of sediment production on the Millstone Watershed (paragraphs 1 and 2, page 5).

PERCENT OF WATERSHED IN EACH CAPABILITY CLASS



MAJOR LAND USE ADAPTATION	LAND CAPABILITY CLASS	DEFINITIONS AND LIMITATIONS
SUITABLE FOR CULTIVATION	I	Very good land for cultivation. Nearly level and productive; not subject to erosion. Needs only ordinary good farming methods.
	II	Good land for cultivation. Mostly gently sloping, only moderately erodible. Some rather wet. Can be farmed safely with easily applied conservation practices.
	III	Moderately good land for cultivation. Mostly moderately sloping. Some too wet or too dry. Can be farmed safely with practical conservation measures, carefully applied and usually in combination of two or more measures. Mostly subject to water erosion in humid areas, and much of it to wind erosion in the Great Plains.
	IV	Fairly good land suitable for occasional cultivation. Generally strongly sloping; often shallow or very sandy.
NOT SUITABLE FOR CULTIVATION	VI	Land well suited for grazing or forestry: Steeply sloping, stony or shallow soil; some droughty. Requires careful management.
	VII	Land fairly well suited for grazing or forestry. Various difficulties encountered in its use, such as steepness of slope, shallowness or looseness of soil, droughtiness and salinity. Requires very careful management.

Fig. 2

For purposes of a general hydrologic evaluation, Stony Brook Watershed may be considered as receiving 45 inches of precipitation in a normal year, of which about 15 inches, or one-third, leaves the watershed as surface runoff. The other 30 inches, or two-thirds of the precipitation, is accounted for as evaporation, transpiration, sublimation and deep seepage. The rates at which these processes take place vary tremendously during the year, depending upon the supply and other meteorological conditions.

Mean or average streamflow of Stony Brook, close to its mouth, is slightly more than 50 second-feet. The flow varies seasonally, normally reaching a maximum in late winter or early spring and a minimum in September or October. Monthly values during the period of normal high flow are 3 to 4 times those for normal low flow. Individual years at times show considerable variation from the normal time distribution of runoff. When the records for single years are analyzed closely usually it will be found that high monthly flow is due to one or two storm periods and that if those periods are disregarded the normal seasonal regime still holds.

Because of the large number of variables involved, it is necessary to work with the history of streamflow to determine what may be expected in the future. In such a study consideration may well be given to flow behavior on similar, usually neighboring streams. In applying this information to the Stony Brook Watershed it appears that the flood flow to be expected on an average of once in 10 years is 4,500 cubic feet per second. This is approximately twice that of the 2-year flow, and the 100-year expectancy is one and one-half times the 10-year flow. Figure 3 shows curves indicating the probable flow to be expected on Stony Brook at average intervals of 2, 5, 10, 20, 50 and 100 years for areas from 5 square miles to 47.8 square miles.

The hydrologic characteristics of a watershed are best determined from actual observation and an analysis of historical records of precipitation and runoff. In the absence of such data, watershed characteristics must of necessity be determined from available data on soils, slopes, shape of watershed, erosion and associated land features.

SOURCES OF SEDIMENT

Because of the low slopes, absorptive nature of the soil and other conditions favorable for water retention in the Millstone Watershed, very little sediment finds its way into the Millstone River. Its 2 largest tributaries above Carnegie Lake, Bean Brook and Cranbury Brook, have dams constructed on them within 1/2 mile above their confluence with the Millstone, and in each case less than 2 miles above the head of backwater of Carnegie Lake. A dam on the main stem at Hightstown is about 7 miles above the head of backwater. In all, 8 dams have been constructed on the Millstone River and principal tributaries above Carnegie Lake. They catch most of the sediment derived from the drainage area. Behind several of the dams and on flood plains there is a rank growth of vegetation that further prevents sediment from getting down to Carnegie Lake.

A reconnaissance survey, made after a heavy general rain on August 31, 1950, showed the Millstone waters (at several points) to be running clear. At the same time Stony Brook and most of its tributaries were carrying heavy loads of silt. As a result of this check and the findings of L. C. Gottschalk 1/ in a previous survey, efforts to determine sediment sources were concentrated on Stony Brook.

Inspection of the Stony Brook Watershed, analysis of a complete conservation survey of the watershed lands, and analysis of data from streambank and roadbank surveys indicate that 97.4 percent of the potential sediment produced in Stony Brook Watershed is derived from sheet erosion. Gully erosion contributes 1.4 percent, streambank erosion 1 percent, and roadbank erosion .2 percent (table 2).

1/ *Gottschalk, L. C. Report on Sedimentation in Lake Carnegie. 1939.*

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STONY BROOK WATERSHED
MERCER AND HUNTERDON COUNTIES
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NORTHEASTERN REGION
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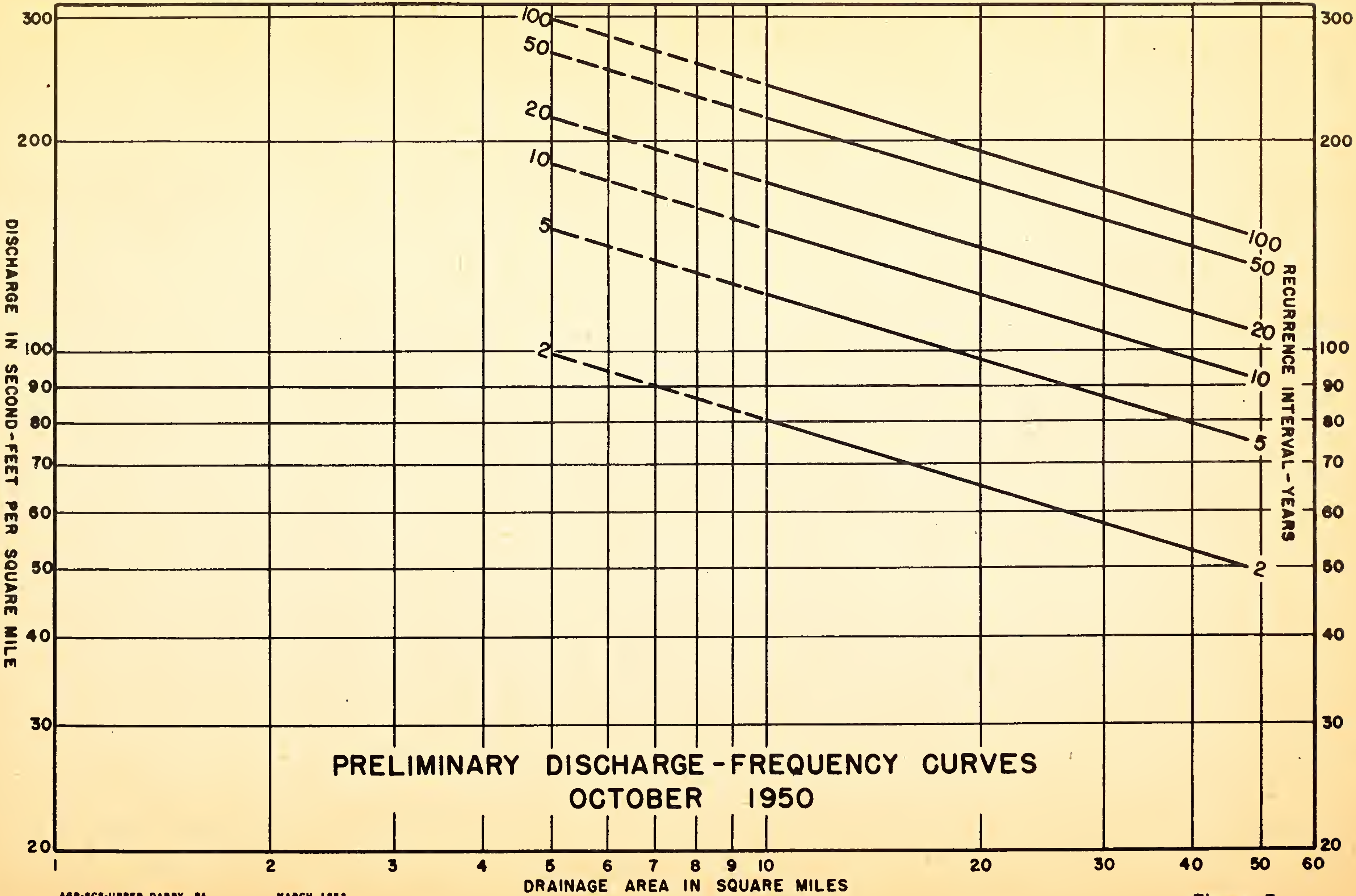

PRELIMINARY DISCHARGE-FREQUENCY CURVES
OCTOBER 1950

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Figure 3

Table 2. ESTIMATED GROSS EROSION
STONY BROOK WATERSHED

TYPE OF EROSION	TONS PER YEAR	PERCENTAGE
Sheet	158,670 1/	97.4
Gully	2,320	1.4
Streambank	1,595	1.0
Roadbank	250	.2
TOTAL	162,835	100.0

1/ *Based on a weight of 88 pounds per cubic foot for soil in place.*

SHEET EROSION

The amount of sheet erosion in a watershed depends on the nature of the soils, slopes, land use, farming practices, and character of rainfall. The conservation survey indicates that no apparent erosion or slight erosion occurs on 46.5 percent of the area. Erosion has been moderate on 36.1 percent, severe on 11.4 percent, and very severe on 3.6 percent of the area (table 3).

The very severely gullied land, all cropland or idle land, occurs on C and D slopes. Very severe erosion occurs on B, C, and D slopes (table 3) from land that is mostly in croplands or idle (table 4). The severe erosion is found almost entirely on B and C slopes--4/5 on cultivated land and 1/5 on pasture and woods.

Table 3. DISTRIBUTION OF EROSION IN EACH SLOPE CLASS (IN PERCENT OF WATERSHED)
STONY BROOK WATERSHED

DEGREE OF EROSION	SLOPE OF LAND IN PERCENT							
	A 0-2	B 2-6	C 6-12	D 12-18	E 18-30	F 30/	Undesignated	Percent of Watershed
No Apparent or Slight	17.8	24.8	2.1	.8	.7	.3	-	46.5
Moderate	.8	31.8	3.2	.2	.1	-	-	36.1
Severe	-	6.0	4.7	.6	-	.1	-	11.4
Very Severe	-	.8	1.6	.7	.1	-	-	3.2
Very Severely Gullied Land	-	-	.2	.2	-	-	-	.4
Undesignated	-	.2	-	-	-	-	2.2	2.4
Percent of Watershed	18.6	63.6	11.8	2.5	.9	.4	2.2	100.0

Heavy rains caused severe sheet and gully erosion west of **Quaker Road and** Old Princeton Pike.

Severe streambank erosion along Stony Brook near Pennington, New Jersey

Table 4. DISTRIBUTION OF LAND USE IN EACH EROSION GROUP (IN PERCENT) STONY BROOK WATERSHED

	No Apparent or Slight Erosion	Moderate Erosion	Severe Erosion	Very Severe Erosion	Very Severely Gullied Land	Roads and Streams	Percent of Watershed
Cropland	13.4	22.0	6.7	1.4	.3	-	43.8
Pasture	4.5	3.3	1.1	.4	-	-	9.3
Woodland	22.0	2.7	1.0	.3	-	-	26.0
Idle	5.1	6.2	2.1	.9	.1	-	14.4
Homestead	1.5	1.9	.5	.2	-	-	4.1
Roads and Streams	-	-	-	-	-	2.4	2.4
Percent of Watershed	46.5	36.1	11.4	3.2	.4	2.4	100.0

GULLY EROSION

Gully erosion is accelerated erosion by concentrated runoff that produces definite channels too deep to be eliminated by normal tillage. The term is confined, in this report, to locations where no well-defined or continuous channels formerly existed. The distribution of gullies by degree of severity in the Stony Brook Watershed is shown in table 5.

The annual loss of soil by gully erosion is estimated to be 2,300 tons or 1.21 acre-feet.

Table 5. EXTENT OF GULLY EROSION IN STONY BROOK WATERSHED

	Acres Affected	Percent of Entire Watershed
Occasional shallow gullies more than 100 feet apart	2,550	8.3
Frequent shallow gullies less than 100 feet apart	103	.3
Occasional deep gullies 1/	176	.6
Frequent deep gullies 1/	5	.02

1/ *Not crossable with tillage implements.*

STREAMBANK EROSION

A detailed survey of the main channel of Stony Brook and sample surveys on its tributaries showed that streambank erosion is occurring at variable rates in different parts of the watershed. In forested areas rates are low enough to be almost negligible. In pasture, however, erosion is considerably accelerated by the trampling of cattle enroute to the water. The most severe streambank erosion on the main stem was caused by a channel block of fallen trees that turned the current into one bank and caused rapid cutting. The results of the streambank survey are summarized in table 6. It is estimated that of the total annual gross erosion in the watershed, 1600 tons, or 1 percent, is derived from streambank erosion.

Table 6. RATE OF STREAMBANK EROSION IN STONY BROOK WATERSHED

Stream	Stream Length (Miles)	Estimated Erosion Rate (ac.-ft./yr.)
Upper Stony Brook	4.25	.0232
Peter's Brook	4.25	.0635
Honey Brook	3.50	.0618
Small Tributaries (upper watershed)	24.80	.2430
Small Tributaries (estates and idle areas near Princeton)	6.80	.0522
Small Tributaries (lower watershed)	6.70	.0657
Stony Brook (upper main stem)	5.00	.0655
Stony Brook (lower main stem)	12.00	.2570
TOTAL (Stony Brook and Tributaries)	72.30	.8321

ROADBANK EROSION

Roadbanks are well vegetated throughout the Stony Brook Watershed and are of little importance as sources of sediment. Areas exposed by maintenance grading and new road construction are rapidly healed by roadside planting or by weeds and shrub species that seed in naturally.

Roadbank erosion along Centerville road, Mount Rose, New Jersey

Roadbank stabilized by revegetation

SEDIMENTATION IN THE RESERVOIR

HISTORY

Silting in the Stony Brook arm of Carnegie Lake became evident soon after the lake was impounded in 1907. Officials became concerned about the situation 15 years later when motorboats, used by coaches for training rowing crews, scraped bottom on their way to and from the boathouse. A survey to determine the water depths between the head of backwater and Harrison Street Bridge (fig. 6), an area of about 50 acres, was made by the University in July 1922. During this survey over 500 soundings were made along 43 separate ranges in the upper part of the lake. On the basis of the soundings, L. C. Gottschalk, Head, Sedimentation Section, U. S. Soil Conservation Service, calculated that approximately 62 acre-feet of sediment had been deposited in this area up to 1922. That was equal to at least 25 percent of the original capacity of this portion of the lake.

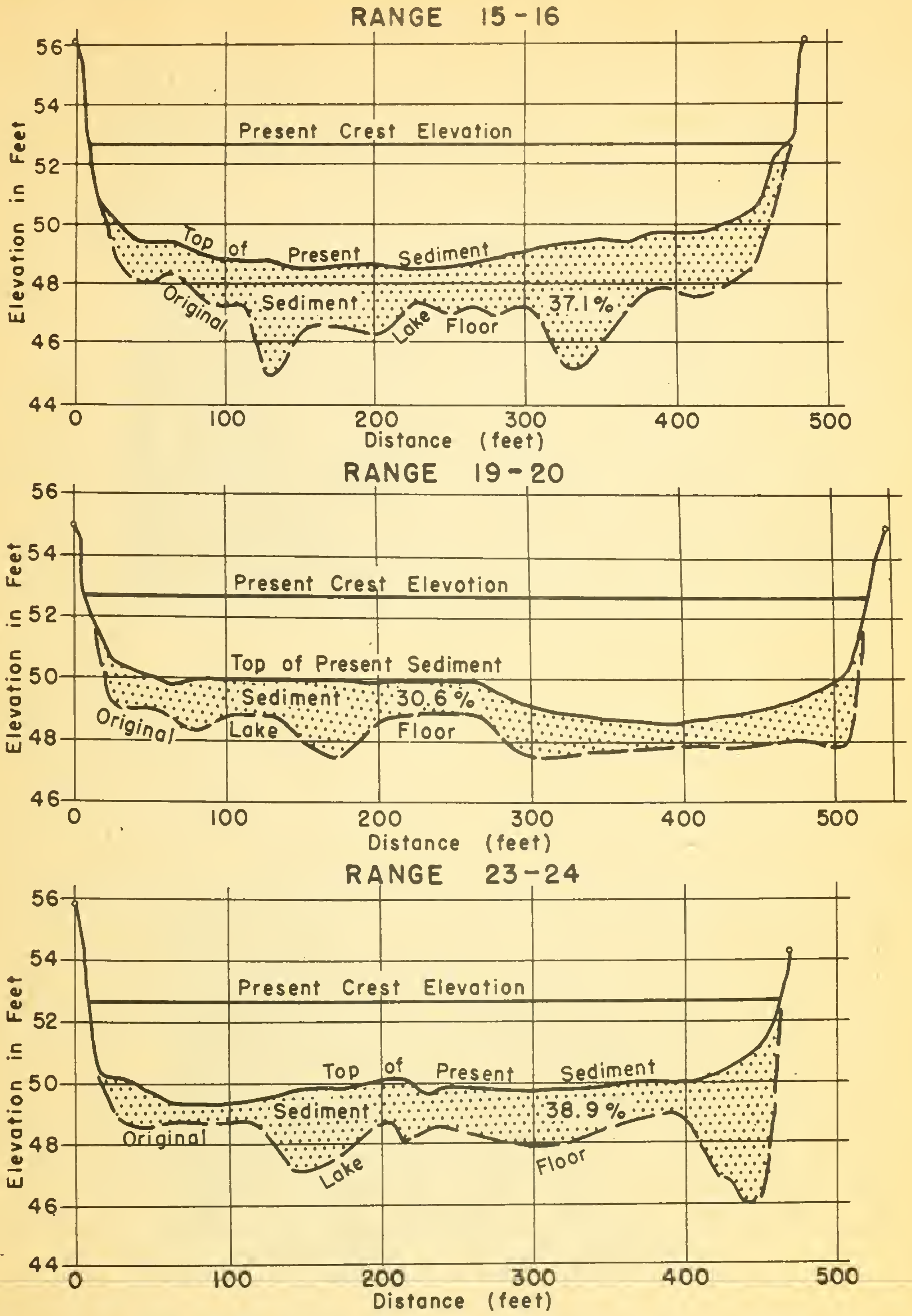
After the 1922 survey, a 4-inch board was placed on the spillway and the water surface of the lake raised a corresponding amount. This expedient served until 1927 when A. E. MacMillan, superintendent of buildings and grounds at Princeton University, constructed an improvised dredge and attempted to open a channel from the boathouse to deeper water. It is his estimate that between 4,000 and 5,000 cubic yards (approximately 3 acre-feet) of sediment were removed from the lake at that time.

By 1937, conditions had become considerably worse. The University found it necessary to purchase a dredge and clean out the entire area from Harrison Street Bridge to the head of backwater. The operation was started early in 1937 and continued intermittently until 1938. By July 1937, 50,000 cubic yards (31 acre-feet) of sediment had been pumped from the lake and deposited in a depression between the right bank of the lake and the Delaware and Raritan Canal. In 1938, between 100,000 and 110,000 cubic yards (65 acre-feet) of sediment were removed. A small amount of dredging was done in 1939. Thus, approximately 100 acre-feet of sediment were removed in the area between Harrison Street Bridge and the head of backwater between 1937 and 1939. The total capacity of this part of the lake at completion of dredging is estimated to have been 252 acre-feet. The 100 acre-feet of material dredged from the lake supposedly included 6 to 8 inches of the original bottom to provide for additional sediment storage.

At the head of the wide portion of the lake, just below the Pennsylvania Railraod bridge, a sediment pocket was excavated to a depth of 8 feet where formerly the original depth was only about 2 feet. This sediment pocket was to provide additional sediment storage to prevent the initial deposits from encroaching upon the dredged area in the vicinity of the boathouse 1/2 mile below.

A sedimentation investigation was made by Gottschalk on July 18, 1939, to determine the extent of silting since 1938 in the dredged area of the Stony Brook arm. Eight ranges were laid out across the lake and 36 observations of sediment were made with a spud. The amount of sediment found in the dredged area was 61 acre-feet. This meant about 25 percent of the total capacity of 252 acre-feet established by dredging from 1937 to early 1939 was lost by July 1939. The silt pocket established at the head of the lake had been reduced from a depth of 8 feet to a depth of 2 feet by a deposit of sand and gravel reported to have been brought down by a single freshet. Although a volume of 61 acre-feet of sediment was actually measured in 1939, equal in volume to all the sediment carried in during the 15-year period 1907-1922, this sediment was very loosely compacted and, on the basis of comparison with compacted sediment in the lower portion of the lake, it was estimated that this volume would be reduced by as much as 50 percent when it reached its ultimate compaction.

CARNEGIE LAKE WATERSHED
NEW JERSEY



TYPICAL SILT CROSS SECTIONS
CARNEGIE LAKE

Fig. 4

Grassed waterways carry water away safely and prevent gullying.

Well managed pastures provide excellent forage for livestock and reduce sedimentation in the reservoir.

Enlargements of aerial photographs on an approximate scale of 400 feet equal to one inch were used for horizontal control during this survey. Three base lines were chained to establish the scale of different section of the photographs. Eighteen ranges were established by triangulation and plotting on the aerial photographs and water and sediment depths were determined along the ranges. Sediment observations were made with an extension auger having a graduated shank, with water depths determined by means of a bell-shaped cast aluminum sounding weight in accordance with methods described by Eakin and Brown. 1/ Measurements along the established ranges were taken at random intervals varying from 5 to 60 feet, the closer intervals being used in the vicinity of channels. Stadia distances were used to locate measurements along the ranges.

COMPUTATIONS

Cross sections of the ranges, showing both the original and the present lake bottom, were plotted (fig. 4). The cross-sectional areas of both the sediment and water were obtained by planimetering. The surface areas of the segments, formed by the ranges and crest shoreline, were planimetered from aerial photographs used in the present survey. The following methods of computation were used to determine the original and present capacities of the reservoir.

(1) Segments 2-14 and 19 were computed by the range formula described by Eakin and Brown. 1/

$$V = \frac{A'}{3}\left(\frac{E_1 + E_2}{W_1 + W_2}\right) + \frac{A}{3}\left(\frac{E_1}{W_1} + \frac{E_2}{W_2}\right) + \frac{h_3\ E_3 + h_4\ E_4 + \ldots}{130,680}$$

where:

V = Original capacity or sediment volume in acre-feet.

A' = The quadrilateral area, i.e., the area in acres of the quadrilateral formed by connecting the points of range intersection with crest contour between the two principal or most nearly parallel ranges.

A = Reservoir area of the segment in acres.

E = The cross-sectional area, in square feet, of original capacity or sediment volume cut by a bounding range.

W = Width (length of bounding range) at crest elevation in feet.

h_3 = The perpendicular distance from the range on a tributary (where the segment is bounded by more than two ranges) to the junction of the tributary with the main stream, or if this junction occurs outside the segment, to the point where the thalweg of the tributary intersects the downstream range.

(2) The original capacity and sediment volume for the segment bounded by the dam and one range (segment 1) was computed using the method described by Eakin and Brown.

For original capacity: $V = A\frac{E}{W} - \frac{H\ B\ L}{174,240}$

For sediment volume:

$$V = A\frac{E}{W} - \frac{L\left(2B - \frac{E}{W}s\right)\frac{E}{W}}{130,680}$$

where:

L = Length of dam in feet.

B = Width of base of dam at original bottom of reservoir.

H = Height of dam, original bottom of reservoir to crest line.

S = Slope factor of upstream face of dam.

(3) For segment 15 (a curved segment where random depth measurements were taken) a modified mean depth formula was used:

$$V = \frac{A}{3}\left(\frac{E_1}{W_1} + \frac{E_1 + E_2}{W_1 + W_2} + \frac{E_2}{W_2}\right)$$

(4) Segments 18 and 20 were computed by the mean depth formula

$$V = \frac{2A}{3}\left(\frac{E_1}{W_1}\right)$$

(5) Segments 16 and 17 were computed by the end area method using the following formula.

$V = 1/2\ (A + A_2) \quad x \quad L$

A = End area of downstream range.

A_2 = End area of upstream range.

L = Length of segment in feet.

1/ *Eakin, H. M., Silting of Reservoirs, U. S. Department of Agriculture, Technical Bulletin 524 (Revised by Carl B. Brown, 1939).*

CHARACTER AND DISTRIBUTION OF SEDIMENT

The sediment in Carnegie Lake, excluding the Millstone arm, is reddish brown, high in clay content, and well compacted. Penetration with the spud is usually limited to less than 2-1/2 feet so a soil auger was used for measuring its depth. The sediment was noticeably plastic and compacted enough that it could be removed from the auger by peeling. In the Millstone arm the sediment was gray in color, thin bedded, and not greatly compacted.

Segments 1-5 contained over 120 acre-feet of sediment, an amount equal to 18.5 percent of their original capacity. Sediment depths averaged 1 foot or less on the flats and from 2.2 to 5.7 feet in old channels. The greatest sediment depth found in the lake was 5.7 feet on range 1-2.

The greatest reduction of capacity had occurred in segments 6-14, or in approximately the upper half of the wide part of the lake. In the area 33.1 percent of the original capacity had been replaced by sediment.

The section from Harrison Street Bridge to the Pennsylvania Railroad bridge is of special interest because it was dredged in 1937-1939. This area, at the time of a survey in 1922, had lost 28 percent of its capacity. The dredging operation restored the original capacity plus an 11 percent increase. In July of the same year that dredging ceased, a survey by L. C. Gottschalk showed a loss of 25 percent of this new storage capacity, although the sediment was not compacted and it was estimated that it might have decreased 50 percent in volume with time. During the present survey (1950) the sediment was found to be well compacted. It had replaced 34.6 percent of the capacity of the dredged area.

The 8-foot deep sediment pocket, created by dredging near the Pennsylvania Railroad bridge in segment 15 and reported as being 2 feet deep in the 1939 survey, was 19 feet deep in 1950 and had a rocky bottom. Gravel and large rocks had been washed into the shallow water just below this point. Local residents reported that the pocket had been scoured out during a recent period of high water.

The portion of the lake confined in the original stream channel above the railroad bridge was 6.7 percent filled with sediment. This amount retained in this channel probably varies from time to time as each period of high water scours out the channel which in turn fills again during low water periods.

The Millstone arm contains 1.7 percent of the total sediment in the lake. The original storage capacity of the Millstone arm was 7.3 percent of the original total storage capacity of the lake. Only 5.6 percent of this capacity has been lost to sediment in spite of a much larger watershed than Stony Brook Watershed, and a heavy weed growth that makes conditions favorable for sediment deposition.

COMPARISON OF SEDIMENTATION RATES WITH EROSION LOSSES

The amount of sediment deposited in Carnegie Lake represents only a portion of the total amount of soil material eroded in the watershed. Most of the soil moves only part way down the slopes and comes to rest in natural waterways and small stream valleys as colluvial or alluvial deposits. Under present conditions, gross erosion in Stony Brook Watershed is estimated to be 162,835 tons per year while deposition in the Stony Brook arm of the lake amounts to 10,313 tons per year. Of the total gross erosion of 162,835 tons, 158,670 tons is estimated to come from sheet erosion. One of the methods of effecting a permanent reduction in the rate of sediment inflow is land conversion and the establishment of an intensive land treatment program on the watershed to control sheet erosion on the farmland. Such a

ANNUAL SEDIMENT ACCUMULATION IN CARNEGIE LAKE

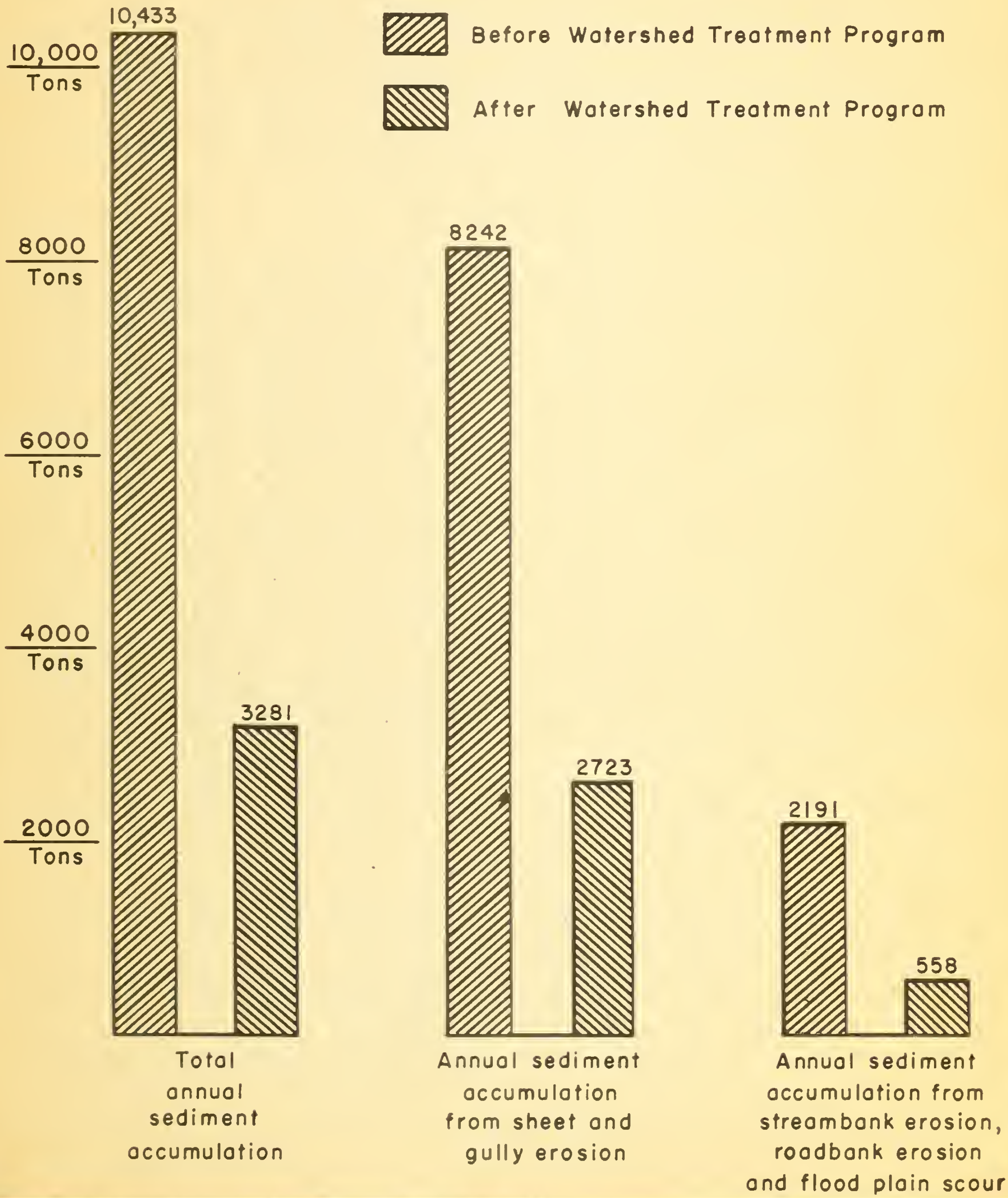


Fig. 5

program for the Stony Brook Watershed was developed in 1951. It will have the double benefit of reducing siltation in Carnegie Lake, and providing for more permanent productivity of the farmland.

Figure 5 shows the estimated reduction in sediment accumulation that could be effected by a land treatment program.

These effects on sediment production in the watershed are correlated closely with soil loss. It is estimated that, under present conditions, 79 percent of the sediment is a result of sheet and gully erosion from watershed lands. The remainder of the sediment, 21 percent is a result of streambank erosion and roadbank erosion. The average annual sediment accumulation to date is 10,433 tons. It is expected that the sediment accumulation, when the land treatment program is established, will be approximately 3,300 tons per year, about 17 percent of the sediment coming from streambank and roadbank erosion, and 83 percent from sheet and gully erosion off the watershed lands.

The reduction in sedimentation in Carnegie Lake, due to the recommended watershed treatment program, is calculated as approximately 7,100 tons per year, or 68 percent.

RECOMMENDATIONS

1. It is recommended that the Stony Brook-Millstone Watershed Association continue its support of the land treatment program and streambank control work as outlined in the work plan.

2. It is recommended that the University complete its survey of possible sediment basins above Carnegie Lake in the near future, to prevent further silting of the lake while the land treatment program and other measures are being carried out.

3. The following operational policies are recommended for consideration by the Soil Conservation District Supervisors.

a. That a greater degree of cooperation between urban interests and landowners on the watershed be developed in order to accomplish, at an early date, the installation of the soil and water conservation plan.

b. That a planned, intensified information and education program be used throughout the watershed.

c. That the neighbor group approach be used in the information and education program, in farm planning and in the establishment and maintenance of practices.

Stony Brook Watershed has been selected for a demonstration of the effectiveness of watershed planning. A soil and water conservation plan has been prepared and progress is being made in establishing the recommended program. The plan describes and evaluates the soil and water problems that affect the rural and urban residents of the watershed and adjacent areas, and presents a plan for remedial measures. It provides a means whereby individual landowners and operators cooperating with soil conservation districts in the two counties can work jointly with all other persons, groups and agencies that are concerned with the problems of the watershed and are willing to assist.

SUMMARY

Carnegie Lake is located on the Millstone River at the point of its juncture with Stony Brook, its main tributary. Investigations show that because of permeable soils, low stream gradient, and dams on most of its tributaries, the Millstone River contributes very little sediment to Carnegie Lake.

The sedimentation survey of the lake shows that over 410 acre-feet (table 7) of sediment has been deposited in it during the past 42.8 years. The resultant reduction in total storage capacity amounts to 30.3 percent.

Considering only the Stony Brook Watershed, the annual rate of sediment accumulation is .20 acre-feet per square mile of drainage area. Actually, the rate of sediment production is considerably higher than is indicated by these figures. An estimated 60 percent of the sediment carried into the lake is not deposited, but

is carried out over the spillway. This can be attributed to the low trap efficiency of this channel-type reservoir due to the low capacity inflow ratio.

The rate of storage depletion of Carnegie Lake is high because of a moderately high rate of sediment production from the Stony Brook Watershed and the small amount of storage capacity provided for the size of drainage area.

Table 7. SUMMARY OF SEDIMENTATION DATA, CARNEGIE LAKE, PRINCETON, NEW JERSEY 1/

	MILLSTONE RIVER AND STONY BROOK	STONY BROOK	UNIT
	(quantity)	(quantity)	
Age 1/	42.8	42.8	Years
Drainage Area	155.0	47.8	Sq. Mi.
Reservoir Data:			
Area:			
Original	260.20	236.33	Acres
Present	260.20	236.33	Acres
Storage Capacity at Crest Elevation:			
Original	1354.99	1256.22	Ac. Ft.
Present	1047.61	954.07	Ac. Ft.
Capacity Per Square Mile of Drainage Area:			
Original	8.74	26.28	Ac. Ft.
Present	6.76	19.96	Ac. Ft.
Sedimentation			
Total Sediment	410.38	405.15 3/	Ac. Ft.
Average Annual Sediment Accumulation	9.59	9.47 3/	Ac. Ft.
Per Square Mile of Drainage Area 2/	.06	.20 3/	Ac. Ft.
Per Acre of Drainage Area 2/	4.21	13.48 3/	Cu. Ft.
By Weight	.11	.337 4/	Tons
Depletion of Storage Capacity:			
Per Year	.71	.75	Percent
At Date of Investigation	22.69	24.05 5/	Percent

1/ Storage began December 5, 1907. Median date of survey September 21, 1950.

2/ Excluding reservoir. (Reservoir area = .41 square mile)

3/ Includes 103 acre-feet dredged in 1937-1939.

4/ Weight of 1 cubic foot of sediment estimated at 50 pounds.

5/ Actual present depletion.

U S DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
ROBERT M. SALTER, CHIEF

NORTHEASTERN REGION
AUSTIN L. PATRICK
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CARNEGIE LAKE, NEW JERSEY

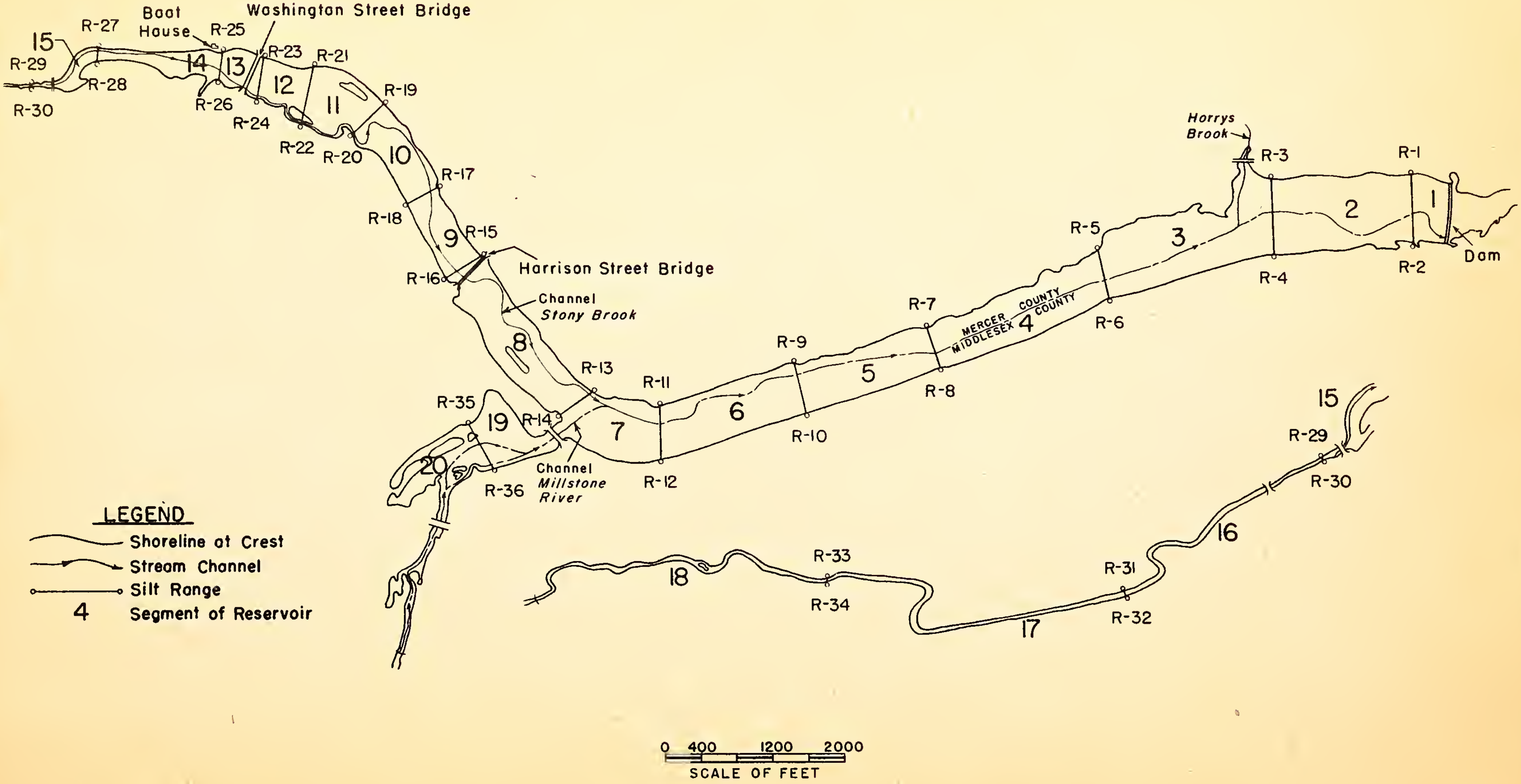

Fig. 6

AGR-SCS-UPPER DARBY, PA.

MARCH, 1952